NUTRIENT INTAKE AND UTILIZATION IN BREEDER TURKEYS

By

DAVID PARKER HOLDER

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1967

Submitted to the Faculty of the Graduate College
of Oklahoma State University
in partial fulfilment of the requirements
for the degree of
MASTER OF SCIENCE
July, 1970

NUTRIENT INTAKE AND UTILIZATION

IN BREEDER TURKEYS

Robin H. Thayer
Thesis Adviser

Jack E. McCroskey

D. Durham
Dean of the Graduate College

ACKNOWLEDGEMENTS

The author wishes to express sincere thanks to Dr. Rollin H. Thayer, Professor of Poultry Science, for his guidance, help, and encouragement during the conduct of this experiment and in the preparation of this thesis. An even greater appreciation is expressed for the training and knowledge that were gained through one and a half years of close association with Dr. Thayer.

Appreciation is expressed to Dr. Robert D. Morrison of the Department of Statistics for his assistance and guidance in the statistical analysis.

Recognition is extended to Eddie Hubbell and Larry Burrus of the Department of Animal Sciences and Industry for their assistance in the collecting of these data.

Special appreciation is extended to my wife, Helen, for her sacrifice, patience, and encouragement during the course of my graduate study.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

One of the major cost items in producing market turkeys is the cost of the day-old turkey poult. This item of cost constitutes approximately 20 percent of the total production cost of both market and breeder turkeys. A substantial reduction in poult cost would be reflected immediately in a significant reduction in overall production cost and a widening of existing profit margins.

In order to reduce this cost of day-old poults, turkey breeders are in the process of developing turkey breeder hens with a high potential for egg production and to house these breeder hens in laying cages. Artificial insemination is used to produce fertile hatching eggs. Emphasis is being placed upon the development of relatively small turkey breeder hens (6 to 10 pounds) which are better suited for a cage environment. These small breeder hens are bred to lay 120 to 150 eggs per hen per year. The breeder toms used to produce semen average between 35 to 45 pounds each, and contribute body size as well as other market characteristics which are present to only a moderate degree in the breeder hen line(s). At the present time, developmental activities in this direction are being undertaken by commercial turkey breeders and feed companies here in the United States, as well as in Europe and South America.

At present, difficulties are being encountered in maintaining turkey breeder hens in laying cages. One of the problems is to provide the proper nutrient intake for these turkey breeder hens so that their full genetic potential for egg production will be expressed. There are very little data available on the role of dietary nutrients in determining feed and nutrient intake of turkey breeder hens, especially when they are housed in a cage environoment. There are also virtually no data available on nutrient intake requirements for optimum egg production and hatchability of turkey breeders housed in cages.

In view of the above discussion, the objectives of this experiment were to determine the effects of dietary energy and dietary protein on feed, protein, and energy intake, and the subsequent effects upon egg production, egg weight, body weight changes, and reproductive performance.

CHAPTER II

REVIEW OF LITERATURE

Very little has been reported in the literature pertaining to the nutrient requirements for turkey breeder hens, or the effect of dietary energy (kilocalories of metabolizable energy in estimated dietary weight) and dietary protein (grams of protein in estimated dietary weight) on feed consumption and nutrient intake. This is true of turkey breeder hens maintained both on the floor and in laying cages. Current data on feed consumption, protein and energy requirements, and the effect of dietary energy and dietary protein on feed consumption and nutrient intake are summarized in the following discussion.

Feed Consumption

Atkinson et al. (1967) ran trials with Broad Breasted Bronze and Broad Breasted White hens to study calcium requirements of breeder turkeys. The average feed consumption during these trials with the hens maintained in individual laying cages was approximately 220 grams per bird per day.

Wolford et al. (1963) in a study with caged turkey breeders reported a daily feed intake of 236 (± 54) grams in Experiment I, and 261 (± 53) grams in Experiment II. In these experiments, total egg production was found to be correlated with feed intake such that those

hens that produced the greatest number of eggs did have the highest daily feed intake.

In another experiment, Wolford et al. (1962) housed Broad Breasted Bronze hens in individual laying cages on a light regime study. During these experiments the hens average 220 grams per hen per day feed consumption.

Energy Level

Dymsza, Bourcher and McCartney (1954) fed rations, which varied in productive energy content from 249 to 888 calories per pound, to White Holland turkeys during the latter part of the breeding season. Production rate, fertility, and body weight were not affected. However, the hatchability of fertile eggs appeared to be directly related to the energy content of the ration. Efficiency of feed utilization progressively increased with each increase in energy level, although calorie intake was greater on the high energy than on the low energy rations.

Robble and Clandinin (1959) found that the average daily feed consumption of turkey breeders was little affected by variations in the energy level of the rations. Reproduction performance of the turkey breeders was not affected by different levels of productive energy or protein. These two reports would indicate that turkey breeder hens do not eat to meet an energy requirement, and that energy level has little effect on feed consumption.

Protein Level

Jensen and McGinnis (1961) conducted experiments on large white breeder turkeys in which several levels of protein were fed. There was no significant difference in fertility, egg production, feed consumption, average egg weight, or hatchability of fertile eggs due to protein level even when a protein level of 10 percent was used.

Anderson (1964) ran studies with large type white females. He used levels of 14.5, 16.5, and 18.5 percent protein with a level of 1320 kilocalories of energy per pound. Two additional rations of 14.5 and 16.5 percent protein with 4 percent fat (which added 72 kilocalories per pound) were used. With the 14.5 percent protein level, there was a slightly higher average feed and energy consumption. With the higher levels of protein, feed consumption was consistently lower with the higher energy level. Turkeys fed the higher protein levels with no fat added had a consistently higher egg production. The different levels of protein or energy had no significant effect on reproductive performance.

Anderson used the same experimental design with Jersey Buff females and found that an increase of 72 kilocalories of metabolizable energy did result in a significant decrease in feed intake whereas energy consumption remained practically the same. This report indicates that turkey hens eat to fulfill an energy requirement as long as protein intake is adequate.

CHAPTER III

EXPERIMENTAL PROCEDURES AND METHODS

General Procedure

This experiment consisted of a feeding trial conducted in the Turkey Cage Laboratory on the Oklahoma State University Poultry Farm. The laboratory contains 144 individual wire cages which are arranged in four rows with thirty-six cages per row. Since no uniformity trials have been run in this house, a randomized block experimental design was employed.

Each cage is sixteen inches wide, thirty inches long, and thirty inches tall, and is equipped with an automatic waterer, feeder, and feed storage container. The individual feed storage containers make it possible to weigh the feed separately for each hen, and permit the individual hen to be considered as an experimental unit.

The building is equipped with four forced-air ventilators and four gas stoves for temperature and ventilation control. The temperature during the experiment varied from a low of 29°F to a high of 80°F. The laboratory was supplied with artificial light by incandescent lamps which were controlled by automatic time clocks.

The trial began on February 10, 1970 and ran through April 14, 1970. The turkey breeders were thirty-six weeks old at the start of the experiment and forty-five weeks old at its termination. The turkeys used in the experiment were Large Whites obtained from Yoder, Inc.

The turkeys were raised on the Oklahoma State University Poultry Farm. The females were started in batteries and raised in wire cages. The males were raised on litter and maintained in individual pens, on litter, in a separate building throughout the experiment. All turkeys were fed the same rations until the feeding trial started.

Lighting Schedule

Starting at twenty-nine weeks of age the breeder toms were given fourteen hours of continuous light and ten hours of continuous darkness. The breeder hens were placed on this same lighting schedule at thirty-two weeks of age. Both hens and toms remained on this lighting schedule for the remainder of the experiment.

Artificial Insemination

The hens were first artificially inseminated one day before the experiment began and every three weeks thereafter. Pooled semen randomly collected from the toms was used to inseminate the hens.

Collecting, Storage and Incubation

Eggs were collected three times daily and placed in a refrigerator at approximately 50°F. At the end of the day they were fumigated and then taken to the egg storage room in the Poultry Science Building on the Oklahoma State University Campus. The eggs were held at 55°F and a relative humidity of 70 percent. The eggs were held till the end of each seven day period. They were then set in Jamesway incubators and fumigated again. Eggs were candled and fertile eggs transferred to

hatching trays at twenty-four days of incubation. The eggs which were not transferred were broken out to check for early embryonic mortality.

Data Collection and Statistical Analysis

The feeding trial was divided into nine periods. Each period was seven days in length. Individual feed consumption data were collected at the end of each period. Each hen was weighed at the beginning and at the end of the feeding trial. Egg production was recorded daily, and all eggs were weighed individually. A record of fertile eggs, and poults hatched for each individual hen for each period was kept. All data were punched onto IBM cards at the end of each experimental period.

Analysis of variance was calculated for each experimental period, using the method outlined by Steel and Torrie (1960). The following responses were involved in these analyses: feed weight consumption, protein consumption, body weight gain, number of eggs produced, egg weight, number of fertile eggs, and number of poults hatched. The data obtained for the various responses are presented in tables as means and as analyses of variance by response variables.

In the analysis of variance tables, energy stands for the two energy levels, and protein stands for the three calorie:protein ratios. Error A is the block by energy, block by protein, and block by energy by protein sum of squares and is used to test block, energy, protein, and energy x protein. Error B is block by period, block by energy by period, block by protein by period, and block by energy by protein by period sum of squares and is used to test period, energy x period, protein x period, and energy x protein x period. Residual A is hen

in treatment in block sum of squares, and residual B is hen by period and hen by period in treatment in block sum of squares. Only F values greater than one were placed in the tables.

Experimental Diets

Six experimental diets were fed during this trial, with each diet being fed to sixteen breeder hens. Treatments were randomly assigned to the birds so that there would be four per diet per block. The diets included two energy levels and three calorie:protein ratios with a factorial arrangement of treatments. Treatment arrangements are shown in Table I. Composition of the six diets used in this study are shown in Table II.

The two levels of energy used were 281.25 and 312.50 kilocalories of metabolizable energy per 100 grams of diet for levels 1 and 2, respectively. The three calorie:protein ratios used were (1) 15.0 kilocalories per gram of protein, (2) 17.0 kilocalories per gram of protein, and (3) 19.0 kilocalories per gram of protein.

In an effort to maintain the same dietary weight in each of these six experimental diets, sand was used. Work done by Harman (1963) showed that sand had no significant effect on egg production when added in quantities which were in excess of that used in this study.

TABLE I

FACTORIAL ARRANGEMENT OF TREATMENTS

Energy Level	Calorie to Protein Ratio		
	1 (15:1)	2 (17:1)	3 (19:1)
1 (281.25 Kcal)	Diet 1	Diet 2	Diet 3
2 (312.50 Kcal)	Diet 4	Diet 5	Diet 6

TABLE II

PERCENTAGE COMPOSITION OF EXPERIMENTAL DIETS

Ingredient	Diet 1	2	3	4	5	6
Corn	36.19	39.01	41.23	32.54	35.63	38.13
Milo	15.52	16.72	17.67	13.94	15.28	16.34
Soybean oil meal (50%)	15.92	13.10	10.87	18.71	15.58	13.10
Meat and bone scrap (50%)	2.23	1.83	1.52	2.62	2.18	1.84
Fish meal (60%)	3.18	2.62	2.17	3.74	3.12	2.62
Blood meal (80%)	2.55	2.10	1.74	2.99	2.49	2.10
Alfalfa meal (17%)	2.55	2.10	1.74	2.99	2.49	2.10
Whey, dried	1.59	1.31	1.09	1.87	1.59	1.31
Distillers solubles	2.23	1.83	1.52	2.62	2.18	1.84
Yeast culture	1.53	1.26	1.04	1.80	1.50	1.26
dl-Methionine	0.06	0.05	0.04	0.07	0.06	0.05
Tallow	2.91	2.91	2.91	7.76	7.76	7.76
VMC-60[a]	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Dicalcium phosphate	3.30	3.55	3.74	3.07	3.34	3.55
Calcium carbonate	4.30	4.30	4.30	4.28	4.29	4.52
Sand	4.94	6.31	7.42	0.00	1.51	2.48
Total	100.00	100.00	100.00	100.00	100.00	100.00

[a]See Table III

TABLE III

COMPOSITION OF VMC-60

Vitamins and Minerals	Units	Adds per lb. of finished ration
Vitamin A	U.S.P.	8,000
Vitamin D_3	I.C.U.	1,200
Vitamin E	I.U.	6
Vitamin K	Mg.	3
Vitamin B_{12}	Mg.	0.008
Riboflavin	Mg.	4
Niacin	Mg.	32
Pantothenic Acid	Mg.	8
Choline Chloride	Mg.	500
Manganese	Mg.	27.7
Iodine	Mg.	0.86
Cobalt	Mg.	0.59
Iron	Mg.	21.8
Copper	Mg.	1.65
Zinc	Mg.	22.7

CHAPTER IV

RESULTS AND DISCUSSION

Health of Birds

Shortly after the hens were transferred to the turkey cage laboratory and placed in individual cages, several of the hens died. Most of the other hens appeared unhealthy and had watery-green droppings. A number of medications were tried without much success. The reader is referred to Appendix A for a pathological report by John M. Whittaker, D.V.M. on the condition of the birds shortly before the hens went on experiment.

A mycotic infection complicated by the stress of individual cages and the medications seemed to be the primary cause of the conditions of the hens. The males which were on the floor throughout the experiment showed none of the symptoms common to the females.

In order to conduct the experiment, the ninety-six healthiest birds were picked and randomly placed on treatment. The reader is therefore cautioned that as he looks at the data presented, he should remember that most if not all of the birds used in this experiment were not healthy. Mycosis in turkeys and its prevention is a problem which will require a considerable amount of research work in the immediate future. This problem will become more critical as turkeys are subjected to more and more stress under commercial production conditions.

Feed Consumption

Feed consumption varied from a low of 153 grams per hen per day to a high of 257 grams per hen per day. Mean values for feed consumption are presented for each treatment by periods in Table IV. The overall mean for feed consumption was 211.74 grams per hen per day. This figure agrees favorably with those reported by Atkinson et al. (1967) and Wolford et al. (1962, 1963) who obtained values of 220, 220, and 236 grams feed consumption per hen per day, respectively. They agree even closer when it is realized that, due to poor health, several birds went off feed during the experimental period and depressed the average figure for feed consumption.

A statistical analysis of the feed consumption data shows that treatments had no significant effect on feed consumption (Table V). This tends to indicate that neither energy nor calorie:protein ratio (therefore protein intake) had any effect on feed consumption. The turkeys fed energy level one did have a slightly higher feed consumption (215.43 grams per hen per day) than did those which received energy level two (208.05 grams per hen per day).

When the diets were calculated for the experiment, it was assumed from data made available by the breeder, that the hens would eat 320 grams per day. Due to this one-third reduction in expected feed consumption, the difference in the two energy levels was small. Therefore changes due to energy level are hard to detect.

Energy Consumption

Means for energy consumption are presented in Table VI. Energy consumption varied from a low of 417 kilocalories of metabolizable

TABLE IV

AVERAGE FEED CONSUMPTION IN GRAMS
PER HEN PER DAY BY PERIOD

Diet	Period								
	1	2	3	4	5	6	7	8	9
1	152.77	182.95	197.68	199.02	205.54	187.50	213.93	220.63	213.93
2	184.91	236.43	211.43	225.59	256.52	218.57	250.00	237.68	239.73
3	193.57	203.75	229.55	207.41	213.21	218.75	237.05	233.57	229.82
4	183.13	200.36	214.11	222.50	225.89	220.63	222.41	229.55	237.59
5	159.20	198.42	212.59	204.73	238.21	203.75	225.18	233.04	228.21
6	157.23	166.61	175.89	216.96	200.80	196.79	224.11	213.04	206.16

TABLE V

ANALYSIS OF VARIANCE FOR GRAMS FEED CONSUMPTION

Source of Variation	df	SS	MS	F
Block	3	347,826.1887	115,942.0629	
Energy	1	575,928.5289	575,928.5289	
Protein	2	1,537,263.3079	768,631.6539	
Energy x Protein	2	3,623,104.8356	1,811,552.4178	1.98
Error A	15	13,712,237.0544	914,149.1370	
Period	8	13,060,717.6759	1,632,589.7099	21.01**
Period x Energy	8	428,822.3981	53,602.7998	
Period x Protein	16	1,472,119.5880	92,007.4742	1.18
Period x Energy x Protein	16	1,329,680.1435	83,105.0090	1.07
Error B	144	11,189,467.1944	77,704.6333	
Residual A	72	29,938,640.7500	415,814.4549	
Residual B	576	41,082,561.0000	71,323.8906	

**Significant (P < .01)

TABLE VI

AVERAGE ENERGY CONSUMPTION IN KILOCALORIES
PER HEN PER DAY BY PERIOD

Diet	Period								
	1	2	3	4	5	6	7	8	9
1	416.64	498.94	539.12	542.78	601.46	511.36	583.44	601.70	583.44
2	504.30	644.80	576.62	615.34	699.59	596.10	681.82	648.21	653.81
3	527.92	555.76	626.14	565.58	581.57	596.59	646.59	637.09	626.79
4	554.92	607.14	648.81	674.24	684.52	668.56	673.97	695.62	719.97
5	482.41	601.27	644.21	620.40	721.77	617.33	682.27	702.38	691.65
6	476.46	501.14	533.01	657.47	608.58	596.68	679.11	643.10	624.43

TABLE VII

ANALYSIS OF VARIANCE FOR KILOCALORIES OF ENERGY CONSUMPTION

Source of Variation	df	SS	MS	F
Block	3	2,503,933.2989	834,644.4330	
Energy	1	19,130,228.9076	19,130,228.9076	2.76
Protein	2	12,183,007.6087	6,091,503.8044	
Energy x Protein	2	29,762,066.8432	14,881,033.4216	2.15
Error A	15	103,982,737.4699	6,932,182.4980	
Period	8	108,625,031.3251	13,578,128.9156	22.04**
Period x Energy	8	4,586,732.1718	573,341.5215	
Period x Protein	16	12,296,127.6047	768,507.9753	1.25
Period x Energy x Protein	16	10,911,305.7905	681,956.6119	1.11
Error B	144	88,725,563.5735	616,149.7470	
Residual A	72	240,131,332.5643	3,335,157.3967	
Residual B	576	335,577,380.5962	582,599.6191	

**Significant ($P < .01$)

energy per hen per day to a high of 722 kilocalories per hen per day. The overall mean for energy consumption was 608.80 kilocalories of metabolizable energy per hen per day.

There was no significant difference in energy consumption due to treatment (see Table VII). This would indicate that the hens might be eating to meet an energy requirement. Thus energy level could be a limiting factor in feed consumption. However, since energy level had no significant effect on feed consumption in this study, it can not be positively stated that energy level is a factor that controls feed consumption. Studies need to be run with wider differences in energy level to see if they would have an effect on feed consumption.

Protein Consumption

There was a significant difference ($P < .01$) in protein consumption due to calorie:protein ratio (Table VIII). Examination of the table of means (Table IX) reveals that the narrowiest ratio had a higher daily protein intake than the middle ratio, which also had a higher daily protein intake than the widest calorie:protein ratio. The overall daily protein consumption of the three calorie:protein ratios is presented in Table X.

TABLE X

OVERALL AVERAGE PROTEIN CONSUMPTION IN GRAMS PER HEN PER DAY

Calorie:Protein Ratio		
1	2	3
40.02	37.21	31.27

TABLE VIII

ANALYSIS OF VARIANCE FOR GRAMS PROTEIN CONSUMPTION

Source of Variation	df	SS	MS	F
Block	3	6,639.3175	2,213.1058	
Energy	1	83,999.3894	83,999.3894	3.74
Protein	2	564,430.1932	282,215.0966	12.56**
Energy x Protein	2	132,425.7657	66,212.8828	2.95
Error A	15	336,944.1716	22,462.9448	
Period	8	388,663.5571	48,582.9446	22.92**
Period x Energy	8	14,528.5389	1,816.0674	
Period x Protein	16	45,741.1224	2,858.8201	1.35
Period x Energy x Protein	16	34,541.0138	2,158.8134	1.02
Error B	144	305,169.9337	2,119.2357	
Residual A	72	890,566.7406	12,368.9825	
Residual B	576	1,140,299.2372	1,979.6862	

**Significant (P < .01)

TABLE IX

AVERAGE PROTEIN CONSUMPTION IN GRAMS
PER HEN PER DAY BY PERIOD

Diet	Period								
	1	2	3	4	5	6	7	8	9
1	27.78	33.26	35.94	36.19	40.10	34.09	38.90	40.11	38.90
2	29.66	37.93	33.92	36.20	41.15	35.06	40.11	38.13	38.59
3	28.08	29.25	32.96	29.75	30.61	31.40	34.33	33.53	32.90
4	36.99	40.48	43.25	44.95	45.63	44.57	44.93	46.37	48.00
5	28.38	35.37	27.89	36.49	42.45	36.31	40.13	41.49	40.68
6	25.08	26.37	28.05	34.60	32.03	31.40	35.74	34.01	32.88

The overall daily protein consumption was 36.17 grams per hen. It would seem that the hens ate to meet an energy requirement (or some other limiting nutrient factor), and in so doing restricted protein consumption. If this is true, calorie:protein ratio should be a major concern in feed formulation.

Body Weight Change

Nearly all the hens lost weight during the nine weeks of the experiment (Table XI). This probably can be attributed to the health condition of the hens, since there was no significant difference due to treatment (Table XII). The hens did lose less weight on energy level two than on the energy level one (-237 grams per hen and -402 grams per hen, respectively). However, this was mostly due to the low average body weight change for diet 5.

Egg Production

The means for percent egg production are presented in Table XIII. Percent egg production reached a peak of 59 percent during period 2, and then gradually decreased to 43 percent during period 9. There were no significant differences in percent egg production due to treatment (Table XIV).

Egg Weight

Average egg weights for the different treatments by period are presented in Table XV. There was a significant difference ($P < .05$) in average egg weight due to energy-protein interaction (Table XVI). The higher the protein intake the higher the average egg weight. The

TABLE XI

AVERAGE BODY WEIGHT CHANGE IN GRAMS PER HEN FOR ENTIRE EXPERIMENT

Diet	Grams change
1	-573.13
2	-267.50
3	-366.88
4	-208.13
5	- 74.38
6	-430.63

TABLE XII

ANALYSIS OF VARIANCE FOR BODY WEIGHT GAIN

Source of Variance	df	SS	MS	F
Block	3	250,236.4583	83,412.1528	
Energy	1	651,751.0417	651,751.0417	1.25
Protein	2	1,069,089.5833	534,544.7917	1.03
Energy x Protein	2	744,939.5833	372,469.7917	
Error A	15	7,802,307.2917	520,153.8194	
Residual A	72	11,838,175.0000	164,419.0972	

TABLE XIII

AVERAGE PERCENTAGE EGG PRODUCTION
PER HEN BY PERIOD

Diets	Period								
	1	2	3	4	5	6	7	8	9
1	48.21	66.07	54.46	53.57	41.96	50.00	35.50	46.43	46.43
2	46.43	56.25	56.25	54.46	56.25	57.14	53.75	55.36	47.32
3	54.46	61.61	52.68	49.11	43.75	50.00	48.21	50.00	39.29
4	57.14	60.71	58.04	61.61	59.82	53.57	50.89	43.75	49.11
5	55.36	58.93	47.32	49.11	51.79	49.11	45.54	43.75	36.61
6	55.36	50.00	49.11	41.96	46.43	40.18	33.93	31.25	36.61

TABLE XIV

ANALYSIS OF VARIANCE FOR PERCENT EGG PRODUCTION

Source of Variation	df	SS	MS	F
Block	3	10.5405	3.5135	
Energy	1	6.1678	6.1678	
Protein	2	30.5856	15.2928	1.36
Energy x Protein	2	34.8773	17.4387	1.55
Error A	15	168.5498	11.2367	
Period	8	93.9190	11.7399	4.96**
Period x Energy	8	22.9884	2.8736	1.21
Period x Protein	16	20.5185	1.2824	
Period x Energy x Protein	16	21.8102	1.3631	
Error B	144	341.0972	2.3687	
Residual A	72	575.5278	7.9934	
Residual B	576	1,017.2222	1.7660	

**Significant ($P < .01$)

TABLE XV

AVERAGE EGG WEIGHT IN GRAMS PER HEN
BY PERIOD

Diet	Period								
	1	2	3	4	5	6	7	8	9
1	69.44	66.20	67.03	63.19	63.48	59.80	53.50	65.53	56.66
2	67.87	77.49	80.88	76.14	80.83	83.39	75.32	82.12	73.39
3	76.60	77.38	72.17	77.89	69.28	70.81	66.62	66.57	60.77
4	78.48	75.77	76.95	85.55	76.67	79.56	79.90	82.11	75.64
5	69.22	70.70	67.30	72.30	68.34	75.40	67.49	63.91	58.00
6	76.23	76.40	62.76	72.87	58.76	68.73	61.77	59.47	62.01

TABLE XVI

ANALYSIS OF VARIANCE FOR AVERAGE EGG WEIGHT

Source of Variation	df	SS	MS	F
Block	3	564.4426	188.1475	
Energy	1	170.0629	170.0629	
Protein	2	2,367.4395	1,183.7198	
Energy x Protein	2	26,991.4194	13,495.7097	5.90*
Error A	15	34,297.4750	2,286.4983	
Period	8	8,344.3975	1,043.0497	1.59
Period x Energy	8	2,353.1193	294.1399	
Period x Protein	16	7,609.6048	475.6003	
Period x Energy x Protein	16	3,382.8913	211.4307	
Error B	144	94,249.8907	654.5131	
Residual A	72	131,616.0830	1,828.0012	
Residual B	576	276,398.5759	479.8586	

**Significant (P < .05)

turkeys fed energy level two also tended to have a higher average egg weight than the turkeys fed energy level one. This is probably because the turkeys fed energy level two also tended to have a higher protein intake. This energy-protein interaction will be discussed in a little more detail later in this chapter.

Reproductive Performance

Means for percent fertility, percent hatch of fertile eggs, and percent hatch of total eggs set are listed in Tables XVII, XVIII, and XIX, respectively. The number of poults hatched per treatment by period is listed in Table XX. Analyses of variance for these four response variables are given in Tables XXI, XXII, XXIII, and XXIV.

The reproductive performance of these hens, as can be seen by looking at the mean tables was very poor. This can be attributed to at least two things, health of birds, and artificial insemination technique. It is the opinion of the author that the poor health conditions of the birds was the main contributing factor to the low reproductive performance. This would help account for the wide variation among means as revealed in the tables. This variation makes it very hard to pick up any differences due to treatment.

The eggs laid by these hens were in general of a very poor quality for setting. Many of the eggs were soft shelled or misshaped. Less than half of the eggs laid were of good enough quality to set. A small part of the problem was the hens breaking the eggs before they were gathered. It is the authors opinion that the major part of this problem was the health of the hens.

TABLE XVII

AVERAGE PERCENTAGE FERTILITY
PER HEN BY PERIOD

Diet	Period								
	1	2	3	4	5	6	7	8	9
1	39.25	29.44	36.69	38.62	37.50	18.25	32.31	28.62	27.06
2	20.81	18.75	21.25	31.69	32.81	45.87	26.00	28.56	18.62
3	44.81	43.62	43.94	40.62	25.50	25.69	26.56	38.00	18.75
4	38.31	34.69	32.19	41.75	49.75	39.75	42.50	18.75	23.75
5	29.00	20.31	25.50	35.44	21.88	20.31	30.19	9.56	1.25
6	49.00	29.81	29.37	32.31	38.87	14.06	29.19	21.88	21.88

TABLE XVIII

AVERAGE PERCENTAGE HATCH OF FERTILE EGGS
PER HEN BY PERIOD

Diet	Period								
	1	2	3	4	5	6	7	8	9
1	14.56	19.75	42.69	19.31	27.06	6.25	12.50	19.81	19.06
2	6.25	22.94	6.25	21.87	20.87	15.62	25.81	7.31	12.50
3	17.69	27.06	34.69	27.06	27.06	28.13	26.06	10.62	9.38
4	36.81	7.31	17.69	22.94	21.25	15.62	10.00	8.31	10.94
5	6.25	7.31	12.06	22.94	6.25	14.56	12.50	0.00	0.00
6	17.69	20.31	16.69	12.50	13.00	12.50	9.38	0.00	0.00

TABLE XIX

AVERAGE PERCENTAGE HATCH OF TOTAL EGGS SET
PER HEN BY PERIOD

Diet	Period								
	1	2	3	4	5	6	7	8	9
1	9.38	9.56	26.94	15.56	19.75	6.25	10.44	11.44	14.87
2	3.12	13.56	4.69	14.56	16.69	9.37	18.75	4.06	2.50
3	15.06	18.62	25.81	18.75	16.12	14.25	16.62	10.62	5.19
4	28.87	4.37	16.12	16.75	16.87	10.94	6.87	5.19	10.00
5	4.56	6.25	8.94	17.75	6.25	14.06	9.38	0.00	0.00
6	12.00	14.19	8.56	10.44	12.19	6.56	8.31	0.00	0.00

TABLE XX

NUMBER OF POULTS HATCHED
PER DIET BY PERIOD

Diet	Period								
	1	2	3	4	5	6	7	8	9
1	5	5	13	12	6	1	4	5	11
2	1	6	3	9	8	5	12	3	2
3	6	11	14	10	7	6	9	3	2
4	14	3	5	9	11	5	4	2	5
5	3	5	5	7	4	4	2	0	0
6	6	7	5	4	5	4	4	0	0

TABLE XXI

ANALYSIS OF VARIANCE FOR PERCENT FERTILITY

Source of Variation	df	SS	MS	F
Block	3	1.1283	0.3761	
Energy	1	0.0807	0.0807	
Protein	2	1.4210	0.7105	1.13
Energy x Protein	2	0.3593	0.1797	
Error A	15	9.4714	0.6314	
Period	8	2.8798	0.3600	3.20**
Period x Energy	8	0.7105	0.0888	
Period x Protein	16	1.6969	0.1061	
Period x Energy x Protein	16	1.5352	0.0959	
Error B	144	16.2155	0.1126	
Residual A	72	29.3932	0.4082	
Residual B	576	66.7384	0.1159	

**Significant ($P < .01$)

TABLE XXII

ANALYSIS OF VARIANCE FOR PERCENT HATCH OF FERTILE EGGS

Source of Variation	df	SS	MS	F
Block	3	1.1427	0.3809	
Energy	1	1.1202	1.1202	2.99
Protein	2	0.6129	0.3065	
Energy x Protein	2	0.2680	0.1340	
Error A	15	5.6252	0.3750	
Period	8	1.8762	0.2345	2.33**
Period x Energy	8	0.8342	0.1043	1.04
Period x Protein	16	1.8416	0.1151	1.14
Period x Energy x Protein	16	0.9883	0.0618	
Error B	144	14.4990	0.1007	
Residual A	72	16.9995	0.2361	
Residual B	576	46.9841	0.0816	

**Significant ($P < .01$)

TABLE XXIII

ANALYSIS OF VARIANCE FOR PERCENT HATCH OF TOTAL EGGS SET

Source of Variation	df	SS	MS	F
Block	3	0.4047	0.1349	
Energy	1	0.2734	0.2734	1.44
Protein	2	0.3359	0.1697	
Energy x Protein	2	0.1765	0.0883	
Error A	15	2.8479	0.1899	
Period	8	1.1392	0.1424	2.80**
Period x Energy	8	0.3938	0.0492	
Period x Protein	16	0.9893	0.0618	1.22
Period x Energy x Protein	16	0.4582	0.0286	
Error B	144	7.3124	0.0508	
Residual A	72	10.2190	0.1419	
Residual B	576	26.2075	0.0455	

**Significant ($P < .01$)

TABLE XXIV

ANALYSIS OF VARIANCE FOR NUMBER POULTS HATCHED

Source of Variation	df	SS	MS	F
Block	3	5.1258	1.7176	
Energy	1	3.6296	3.6296	1.80
Protein	2	2.9468	1.4734	
Energy x Protein	2	1.4606	0.7303	
Error A	15	30.3056	2.0204	
Period	8	12.365	1.5446	3.31**
Period x Energy	8	5.9954	0.7494	1.60
Period x Protein	16	11.1991	0.6999	1.50
Period x Energy x Protein	16	6.6019	0.4126	
Error B	144	67.2917	0.4673	
Residual A	72	130.7222	1.8156	
Residual B	576	244.7778	0.4250	

**Significant ($P < .01$)

As the analysis of variance tables indicate, there was no significant difference due to treatment in the four response variables used to measure reproductive performance. This is true even though no poults were hatched for diets 5 and 6 during the last two periods. Percent fertility, percent hatch of fertile eggs, and percent hatch of total eggs set all had a tendency to be higher for lower energy level one.

Block Effect

None of the response variables for which an analysis of variance was calculated were significantly affected by blocking. However there were some periods in which there were wide differences in a couple of the variables among blocks. This is especially true of reproductive performance. If there had not been so much variation, a significant difference due to blocking might have shown up. At least until further trials indicate no need for blocking, experiments conducted in the Turkey Cage Laboratory on the Oklahoma State University Poultry Farm should continue to use a block design.

Energy by Protein Interaction

The period means and overall means of several response variables present similar pictures. The overall means for these variables are presented in Table XXV.

By looking at Table XXV, one can see what looks like an energy-protein interaction although it was significant only for average egg weight. Diet 2 is the highest in these variables among the first three diets (Energy level one), and diet 4 is the highest in these

variables for the last three diets (energy level two). Except for diet 1, the variables decline as calorie:protein ratio widens. Again, except for diet 1, energy level one is generally higher when calorie: protein ratios are compared. Diet 4 is the highest in egg production and average egg weight, and since it is also highest in protein consumption, probably indicates a strong influence of protein intake on these two variables. This energy-protein interaction is not fully understood.

Table XXV

Overall Means

Response Variable	Diets					
	1	2	3	4	5	6
Feed consumption (gm)	198.77	228.99	218.52	217.35	211.48	195.32
Energy consumption (Kcal)	542.10	624.51	596.60	658.64	640.41	591.11
Protein consumption (gm)	36.14	36.74	31.40	43.90	37.90	31.13
Egg production (%)	49.40	53.67	49.90	54.96	48.61	42.16
Average Egg Weight (gm)	62.54	77.49	70.90	78.96	68.07	66.56

*See Table I for factorial arrangement of diets.

CHAPTER V

SUMMARY AND CONCLUSION

A feeding trial was conducted to determine the effect of energy level and calorie:protein ratio on feed, protein, and energy intake, and the subsequent effects upon egg production, egg weight, body weight changes, and reproductive performance in the turkey breeder hen maintained in a cage environment. Six experimental diets with a 2 x 3 factorial arrangement of treatments were used. This arrangement included 2 energy levels and 3 calorie:protein ratios.

1. Feed Consumption. With the type of diets used in these experiments, an average feed consumption of 210 to 220 grams per hen per day can be expected.
2. Energy Consumption. The hens tended to consume approximately 600 kilocalories of metabolizable energy per hen per day. Energy level had no effect on energy consumption. However, since the difference between the two energy levels was small, any difference due to energy level would have been hard to detect.
3. Protein Consumption. Calorie:protein ratio had a highly significant effect on protein intake. The wider the calorie:protein ratio, the lower was protein intake. Protein intake seemed to have an effect on egg production and egg weight.

This trial indicates at least 40 grams of protein intake are needed by the turkey breeder hen in a cage environment.

4. Egg weight. There was a significant effect on egg weight due to energy by protein interaction. Energy level two and calorie:protein ratio one produced the largest eggs.
5. Egg Production and Body Weight Change. There was no significant effect due to treatments on egg production or body weight change.
6. Reproductive Performance. Reproductive performance was very low during this trial. None of the treatments used had any significant effect on reproductive performance.

SELECTED BIBLIOGRAPHY

Anderson, D. L., 1964. Effect of body size and dietary energy on the protein requirements of turkey breeders. Poultry Sci. 43: 59-64.

Atkinson, R. L., J. W. Bradley, J. R. Couch, and J. H. Quisenberry, 1967. The calcium requirements of breeder turkeys. Poultry Sci. 46: 207-214.

Dymsza, H., R. U. Boucher and M. C. McCartney, 1954. Influence of dietary fiber and energy levels on reproductive performance of turkey pullets. Poultry Sci. 33: 1159-1163.

Harman, C. K. 1966. Umpublished Thesis. Digestibility studies with laying hens, 92 pages. Oklahoma State University.

Jensen, Leo S., and James McGinnis, 1961. Nutritional requirements for turkey hens: 1. Quantitative requirement for protein. Poultry Sci: 40: 288-290.

Robble, A. R., and D. R. Clandinin, 1959. The relationship of energy and protein to reproductive performances in turkey breeders. Poultry Sci. 38: 141-145.

Steel, R. G. D., and J. H. Torrie, 1960. Principles and Procedures of Statistics. McGraw-Hill Book Co., Inc., New York, New York.

Wolford, J. H., R. K. Ringer, T. H. Coleman and H. C. Zindel, 1962. Body weight and egg production of turkeys as influenced by lighting regime during the growing period. Michigan Agriculture Expt. Quart. Bull. 45: 506-517.

Wolford, J. H., R. K. Ringer, T. H. Coleman, and H. C. Zindel, 1963. Individual feed consumption of turkey breeder hens and the correlation of feed intake, body weight, and egg production. Poultry Sci. 42: 599-604.

APPENDIX

February 4, 1970

Mr. David Holder
Department of Animal
Sciences & Industry
Poultry Industries Building
Oklahoma State University
Stillwater, Oklahoma 74074

Dear David:

Here is the report on your caged turkey trial.

Pathology and other observations:

1. Birds had severe enteritis (nothing specific isolated or observed.

2. Birds had old lesions of gizzard erosion and ulceration. None active but whitish growth under healed lesions.

3. Candida albicans isolated from crop but no gross lesions or pathology observed.

4. Liver swollen and mottled but nothing specific isolated. Liver appeared toxic. (Wanted to have "histo-path" sections run on liver but was thrown away by mistake.)

5. Kidneys swollen.

6. One gizzard bile strained, suggests birds off feed.

7. Birds appeared to me overly fat.

8. Birds still laying and oviduct and ovi appeared relatively in good shape.

9. Birds were not especially light but were in good flesh.

10. Much mucus and even desquamated intestinal lining was noticed in droppings suggests-anemia, toxins or severe stress.

General Observations:

I sincerely feel that this case has been duplicated in caged commercial layers many times. We still have much to learn about caged

birds verses floor birds and we especially need to know more about the "stress" mycotic infections play on the nutritional assimilation of birds on wire.

This flock definitely has had a mycotic infection for some time and coupled with other stresses (for one, being on wire) a "synergistic" damage can occur easily. For example, a mycosis ridden turkey is much more susceptible to the toxic effects of sulfa therapy than one free of any disease drag like crop and intestinal mycosis. If the birds had a mycotic infection at the time of the Sulmet treatment, then I sincerely feel that the combination effect could help account for the liver damage. Naturally other stress factors are involved in this damage, some possibly well hidden. Like most major field conditions today, the problem is not a simple one with a single cause.... but very complex. I strongly suggest that you introduce grit into your program. I have seen this basic simple product help reduce enteric disorders, even on wire.

In general I would say that you have no specific problem but an "enity" brought about by the combination stress of "wire", mycotic infection and other stress agents. Together they have weakened the bird and probably now they are prey to about any opportunistic infection.

Suggestions:

First let me say that this type of research is desperately needed for many reasons. I certainly would not abandon this project but would continue to investigate some different drug treatments and basic nutritional factors (since birds appeared very fat, I suggest a look at the calory-protein ratio).

As I suggested to Dr. Thayer, make sure the feed ingredients are top quality and the mixing is properly supervised. Frankly I have personally made mixing errors in the past (too much concentrate) and induced a rather unique diarrhea and so often ingredients used in "few bird" tests can grow old and musty due to the fact they aren't used up quickly enough.

Most all feed ingredients can support mold growths. Also make sure the water source is okay.

For immediate treatment I'd suggest the following for 4 different groups;

1. 10 pounds of Ferro-Lac per ton for 5 to 7 days followed by continuous low level treatment of Myconox and Hemo-Plex.

2. 5 pounds of Myconox and 5 pounds of Hemo-Plex per ton for 5 to 7 days followed by continuous low level of Hemo-Plex and Myconox.

3. Treat one group with 200 grams (or Amdal's suggested treatment level) of Gallimycin for 5 to 7 days followed by 50 grams continuously.

4. Treat one group with NF180 (200 grams) for 5 to 7 days and drop to 50 grams continuously.

The above treatments are aimed at treating:

1. Ferro-Lac - effective on fungi and bacteria and provides supportive therapy (for dehydration and anemia).

2. Myconox - anti-fungal and supportive.

3. Gallimycin - staph and other gram positive bacteria.

4. NF180 - gram negative bacteria (E. coli, etc.) and some protozoa.

This range of treatment should give us a good wide "poke" at what "ails" that intestine. You might wish to contact Amdal, Hess and Clark for their recommendations.

I'm sure I have over-looked discussing some factors in this case, so give me a call if you feel I have left out a point or two. I will send you my observations on your turkey eggs soon.

Very truly yours,

NAREMCO, INC.

John Whittaker

John M. Whittaker, D.V.M.
Director of Field Services

JMW/da
Enc: Slides
cc: Dr. Rollin H. Thayer, Ph.D.
Mr. W. P. Scott

P. S. In the near future I'll send you a program on starting poults in this type of environment. I'd first like to discuss this subject with Mr. Scott and our other Veterinarian who has had a great deal of experience with commercial layers on wire.

VITA

David Parker Holder

Candidate for the Degree of

Master of Science

Thesis: NUTRIENT INTAKE AND UTILIZATION IN BREEDER TURKEYS

Major Field: Poultry Science

Biographical:

Personal Data: Born at Tulsa, Oklahoma, July 21, 1945

Education: Attended grade school at Sapulpa, Oklahoma; graduated from Sapulpa High School, Sapulpa, Oklahoma; received the Bachelor of Science degree from Oklahoma State University, with a major in Poultry Science, May, 1967; attended Midwestern Baptist Theological Seminary, Kansas City, Missouri; completed the requirements for the Master of Science degree in July, 1970.

Professional Experience: Research Assistant, Poultry Science Department, Oklahoma State University, October, 1967 to May, 1968; Research Assistant, Department of Animal Sciences and Industry, Oklahoma State University, January, 1969 to present.

Date of Final Examination: July, 1970.